

Natural Conditions  
Assessment for Low pH  
Mattaponi River  
Caroline, King William, King and Queen  
Counties, Virginia

**Submitted by**

**Virginia Department of Environmental Quality**

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## Executive Summary

This report presents the assessment of whether low pH in the Mattaponi River watershed is due to natural conditions or whether a Total Maximum Daily Load (TMDL) must be performed because of anthropogenic impacts. The Mattaponi River is located in Caroline, King William, and King and Queen Counties in the York River Basin (USGS Hydrologic Unit Code 02080105). The TMDL waterbody identification codes (WBID, Virginia Hydrologic Unit) for the Mattaponi River are VAP-F23E-03, VAP-F23R-01, and VAN-F21R-02.

There are 1365.2 total stream miles and 16.33 total estuarine square miles in the Mattaponi watershed (National Hydrography Dataset (NHD)). The impaired segments for nutrients / eutrophication biological indicators, chloride, low pH, estuarine bioassessments, and Fish Tissue – benzo(k)fluoranthene are 12.87 miles and 6.87 estuarine square miles of the Mattaponi River. Nutrients / eutrophication biological indicators, chloride, estuarine bioassessments, and Fish Tissue – benzo(k)fluoranthene will be addressed in separate documents.

The drainage area of the Mattaponi River watershed below the Matta and Poni Rivers is approximately 765.14 square miles. The average annual rainfall recorded at Walkerton, VA is 43.92 inches. The watershed is approximately 490,473 acres in size and is predominately forested (67.3 percent). Agriculture encompasses 20.2 percent of the watershed, with 11.5 percent cropland and 8.7 pasture/hayland. Low intensity residential and commercial/industrial areas compose approximately 1.0 percent of the land base. The remaining 11.6 percent of the watershed is comprised of 2.1 percent of transitional areas and grasses, and 7.4 percent wetlands and 2.1 percent open water.

The Mattaponi River was listed as impaired on Virginia's 1998 Virginia Water Quality Assessment 305(b) Report (VADEQ 1998) and 2002 303(d) Report on Impaired Waters (VADEQ 2003) due to violations of the State's water quality standards for nutrients / eutrophication biological indicators (EPA overlist), chloride, pH, estuarine bioassessments, and Fish Tissue – benzo(k)fluoranthene. This report evaluates the pH impairment by determining if natural conditions are the cause of the impairment, thus obviating the need for a TMDL. The nutrients / eutrophication biological indicators, chloride, estuarine bioassessments, and Fish Tissue – benzo(k)fluoranthene TMDLs will be performed on the Mattaponi River watershed in separate documents. Out of 346 pH values collected between March 1992 and September 2005 at station 8-MPN054.17, 51 were below the lower water quality standard for pH of pH 6 SU (Figure E1). Out of 419 pH values collected between February 1990 and August 2005 at station 8-MPN029.08, 75 were below the lower water quality standard for pH of pH 6 SU (Figure E2). Out of 93 pH values collected between August 1997 and September 2005 at station 8-MPN039.10, 13 were below the lower water quality standard for pH of pH 6 SU (Figure E3).

**Figure E1. pH at the Mattaponi River at Rt. 628, 8-MPN054.17, March 1992 to September 2005.**

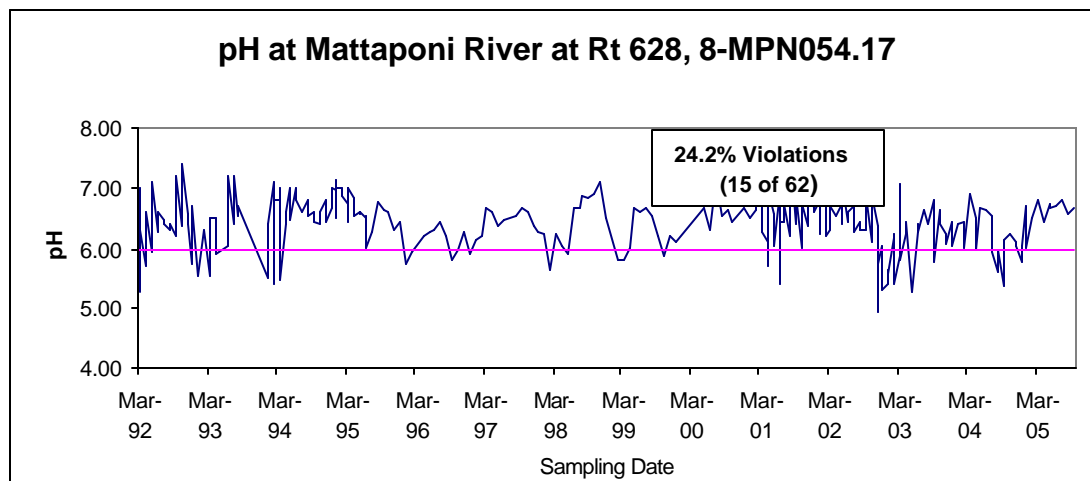


Figure E2. pH at the Mattaponi River at Rt. 629, 8-MPN029.08, February 1990 to September 2005.

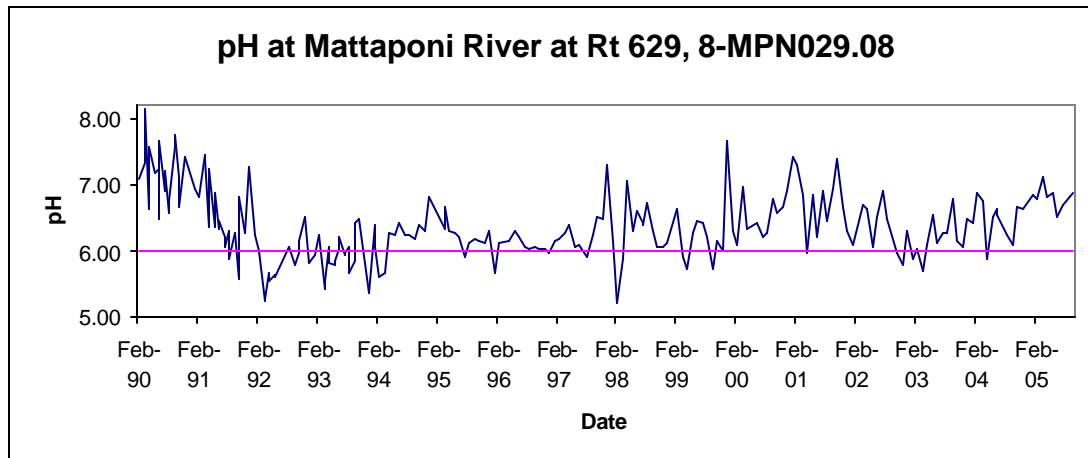
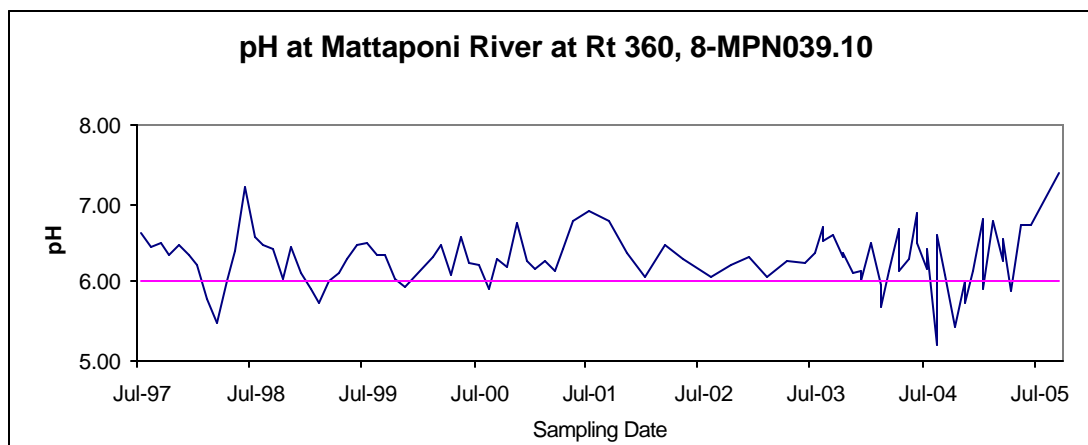


Figure E3. pH at the Mattaponi River at Rt. 360, 8-MPN039.10, August 1997 to September 2005.



According to Virginia Water Quality Standards (9 VAC 25-260-10A), "all state waters are designated for the following uses: recreational uses (e.g., swimming and boating); the propagation and growth of a balanced

indigenous population of aquatic life, including game fish, which might be reasonably expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g., fish and shellfish)."

As indicated above, the Mattaponi River must support all designated uses by meeting all applicable criteria. The Mattaponi River has been assessed as not supporting the aquatic life use due to the exceedance of the pH criteria that are designed to protect aquatic life in Class III waters.

In this document, VADEQ proposes a "Methodology for Determining if pH and DO Impairments in Streams are Due to Natural Conditions." This methodology is based on a study done by MapTech (MapTech 2003) and will be used here to determine if the pH impairments in the Mattaponi River are natural and if the Mattaponi River can be re-classified as Class VII (Swamp Waters).

The level of acidity as registered by pH in a water body is determined by a balance between organic acids produced by decay of vegetative material, and buffering capacity. Conditions in a stream that would typically be associated with naturally low pH include slow-moving, ripple-less waters or wetlands where the decay of organic matter produces organic acids. These situations can be compounded by anthropogenic activities that contribute excessive nutrients or readily available organic matter to these systems. The general approach to determine if DO and pH impairments in streams are due to natural conditions is to assess a series of water quality and hydrologic criteria to determine the likelihood of an anthropogenic source. A logical 4-step process for identifying natural conditions that result in low DO and/or pH levels and for determining the likelihood of anthropogenic impacts that will exacerbate the natural condition is described below.

- Step 1. Determine slope and appearance.
- Step 2. Determine nutrient levels.
- Step 3. Determine degree of seasonal fluctuation (for DO only).
- Step 4. Determine anthropogenic impacts.

No Mattaponi River pH exceedances occurred below 7Q10 flow at upstream stations 8-MPN054.17 or 8-MPN039.10. However, at the lower station, 8-MPN029.08 at Walkerton, two low pH exceedances (pH 5.95 at 1m depth and pH 5.85 1m above bottom) occurred on October 8, 2002 at a flow of 9.6 cfs at the fall line gaging station. These two low pH exceedances were removed from the dataset, dropping the violations to 17.9% (75 of 419).

The Mattaponi River exhibits low slope with significant swamplands, oxbows, and large areas of forested land. There are large inputs of decaying vegetation from such large swampy areas, oxbows, and from other areas of forested land with heavy tree canopy throughout the watershed, that produce acids and lower pH as they decay. These are not considered anthropogenic impacts.

The Mattaponi River exhibits low nutrient concentrations below national background levels in streams from undeveloped areas, which not indicative of human impact.

All VPDES and industrial stormwater dischargers except one industrial stormwater facility are all between 17 and 45 miles upstream of the impaired segments, or downstream of them, and probably exert no impact on the mainstem Mattaponi River at these distances. One remaining industrial stormwater permittee drains to a UT, then into a perennial stream before diluting in a large millpond, also probably exerting no impact on the mainstem Mattaponi River. Short term construction stormwater permits, and CAFOs which cannot discharge legally also probably have no effect on low pH in the mainstem Mattaponi River. The Residential / Commercial land use (0.99%) probably has no pH effect on streams in the watershed. The watershed is predominately forested (67.3 percent).

There is not a close correlation between precipitation amounts and field pH at DEQ ambient water quality monitoring stations. The only discernable pattern has been a general negative correlation of precipitation to pH and the majority of r-values were well below 0.5, which does not indicate a close correlation between the

variables. However the extent to which stream pH is decreased by acid deposition cannot be conclusively determined.

Based on the above information, a change in the water quality standards classification to Class VII Swampwater due to natural conditions, rather than a TMDL, is indicated for the Mattaponi River from its confluence with Maracossic Creek at rivermile 57.17 downstream to the tidal confluence with Garnetts Creek at rivermile 23.60. The total miles classified as Swampwaters are 33.57 rivermiles and 1.96 estuarine square miles. If there is a 305(b)/303(d) assessment prior to the reclassification, the Mattaponi River will be assessed as Category 4C, Impaired due to natural condition, no TMDL needed.

DEQ performed the assessment of the Mattaponi River low pH natural condition in lieu of a TMDL. Therefore neither a TMDL Technical Advisory Committee (TAC) meeting nor a public meeting was involved. Public participation will occur during the next water quality standards triennial review process.

## 1. Introduction

The Mattaponi River was listed as impaired on Virginia's 1998 Virginia Water Quality Assessment 305(b) Report (VADEQ 1998) and 2002 303(d) Report on Impaired Waters (VADEQ 2003) due to violations of the State's water quality standards for nutrients / eutrophication biological indicators, chloride, pH estuarine bioassessments, and Fish Tissue – benzo(k)fluoranthene. This report evaluates the pH impairment by determining if natural conditions are the cause of the impairment, thus obviating the need for a TMDL. The nutrients / eutrophication biological indicators, chloride, estuarine bioassessments, and Fish Tissue – benzo(k)fluoranthene TMDLs will be performed on the Mattaponi River watershed in separate documents.

A glossary of terms used throughout this report is presented as Appendix A.

## 2. Physical Setting

### 2.1. Listed Water Bodies

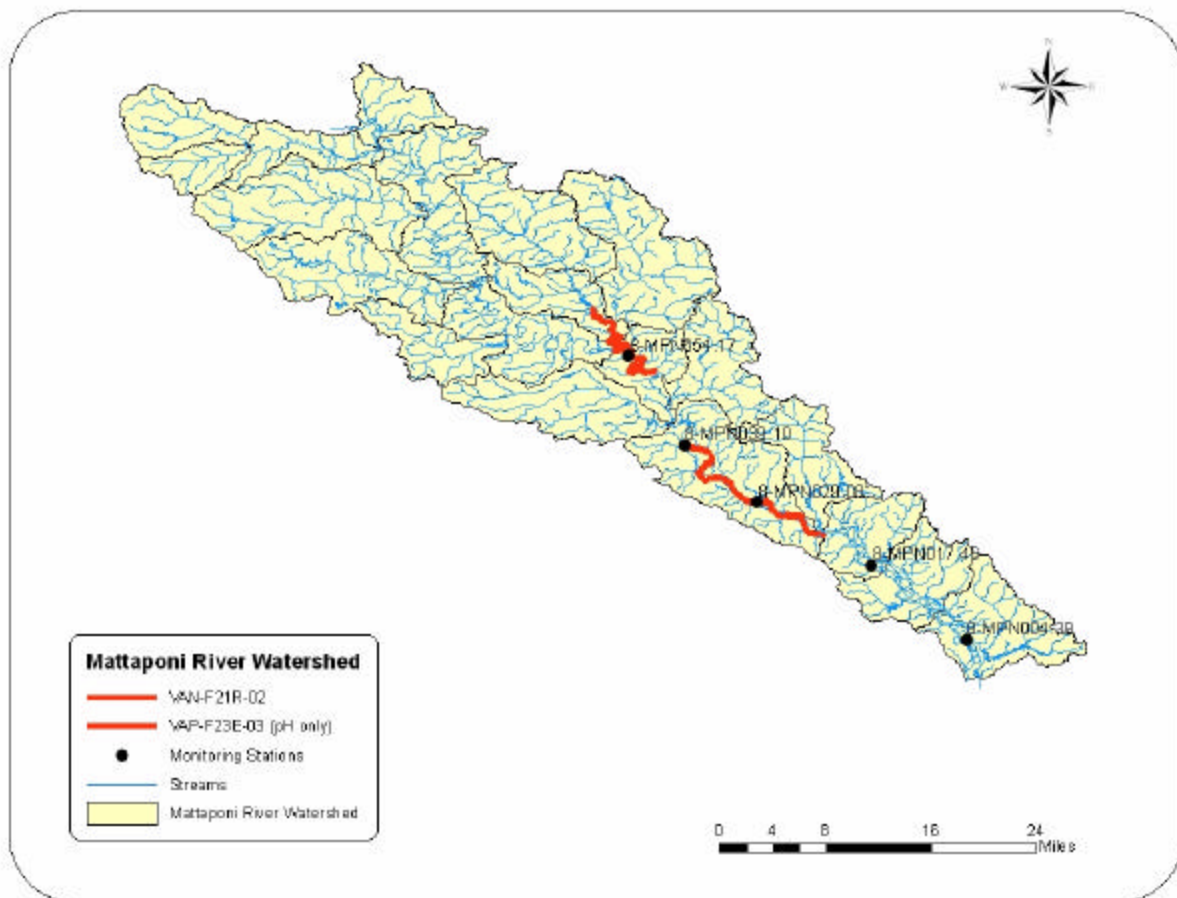
The Mattaponi River is located in Caroline, King William, and King and Queen Counties in the York River Basin (USGS Hydrologic Unit Code 02080105). The TMDL waterbody identification codes (WBID, Virginia Hydrologic Unit) for the Mattaponi River are VAP-F23E-03, VAP-F23R-01, and VAN-F21R-02. There are 1365.2 total stream miles and 16.33 total estuarine square miles in the Mattaponi watershed (National Hydrography Dataset (NHD)). The impaired segments for nutrients / eutrophication biological indicators, chloride, low pH, estuarine bioassessments, and Fish Tissue – benzo(k)fluoranthene are 12.87 miles and 6.87 estuarine square miles of the Mattaponi River. Table 1 describes the two low pH impairments.

**Table 1. Impaired segment descriptions (Mattaponi River)**

Segment (segment ID)	Impairment (source of impairment)	Upstream Limit Description	Downstream Limit Description	Miles Affected
Mattaponi River VAN-F21R-02	pH (unconfirmed natural conditions)	Marracossic Creek confluence	Gravel Run confluence	8.15
Mattaponi River VAP-F23R-01	Fish Tissue – benzo(k)fluoranthene	Herring Creek confluence	Tidal Limit near Aylett	4.72
Mattaponi River VAP-F23E-03	nutrients / eutrophication biological indicators, chloride, low pH, estuarine bioassessments, and Fish Tissue – benzo(k)fluoranthene	Tidal Limit near Aylett	York River mouth	6.87 Sq. mi.



Figure 1. Map of the Mattaponi River study area.



## **2.2. Watershed**

### **2.2.1. General Description**

The Mattaponi River and its major tributaries Maracossic, Chappell, Herring, and Garnetts Creeks, located in Caroline, King William, and King and Queen Counties, Virginia, is a major tributary to the York River. It is approximately 104 miles long and flows southeast from its headwaters where the Matta and Poni Rivers join near Woodford, VA, to its confluence with the York River. The watershed has an area of approximately 765.14 square miles. There are two flow gaging stations on the Mattaponi River, Mattaponi River near Bowling Green, VA, 01674000, with a drainage area of 257 mi<sup>2</sup>, and Mattaponi River near Beulahville, VA, 01674500, with a drainage area of 601 mi<sup>2</sup>. The Beulahville gage is co-located with the VADEQ and USGS original listing station for TMDL waterbody identification code VAN-F21R-02 from Table 1 above.

### **2.2.2. Geology, Climate, Land Use**

#### **Geology and Soils**

The Mattaponi River is in the Atlantic Coastal Plain physiographic region. The Atlantic Coastal Plain is the easternmost of Virginia's physiographic provinces. The Atlantic Coastal Plain extends from New Jersey to Florida, and includes all of Virginia east of the Fall Line. The Fall Line is the easternmost extent of rocky river rapids, the point at which east-flowing rivers cross from the hard, igneous and metamorphic rocks of the Piedmont to the relatively soft, unconsolidated strata of the Coastal Plain. The Coastal Plain is underlain by layers of Cretaceous and younger clay, sand, and gravel that dip gently eastward. These layers were deposited by rivers carrying sediment from the eroding Appalachian Mountains to the west. As the sea level rose and fell, fossiliferous marine deposits were interlayered with fluvial, estuarine, and beach strata. The youngest deposits of the Coastal Plain are sand, silt and mud presently being deposited in our bays and along our beaches (<http://www.geology.state.va.us/DOCS/Geol/coast.html>).

Soils for the Mattaponi River watershed were documented utilizing the VA State Soil Geographic Database (STATSGO). Two general soil types were identified using in this database. Descriptions of these soil series were derived from queries to the USDA Natural Resources Conservation Service (NRCS) Official Soil Series Description web site (<http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdname.cgi>). Figure 2 shows the location of these general soil types in the watershed.

Soils of the Emporia-Johnston-Kenansville-Remlik-Rumford-Slagle-Suffolk-Tomotley (VA027) series are very deep to deep, and vary between well drained to poorly drained with moderately slow or slow permeability. They formed in moderately fine-textured stratified fluvial and marine sediments on the upper Coastal Plain and stream terraces.

Soils of the Iredell – Pacolet – Chewacla – Poindexter – Wilkes – Orange - Goldston series (VA029) consists of shallow to deep to very deep to weathered bedrock, poorly drained to excessively drained, very slow to rapidly permeable soils. These soils formed in material weathered from diabase, diorite, gabbro, formed in recent alluvium washed largely from soils formed in residuum from schist, gneiss, granite, phyllite, and other metamorphic, igneous rocks, basic rocks or a mixture of basic and acidic rocks, intermediate and mafic crystalline rocks, fine-grained metavolcanic rocks in the Carolina Slate Belt, and other rocks high in ferro-magnesium minerals. They are on uplands throughout the Piedmont, floodplains and in alluvial deposits. Slope ranges from 0 to 60 percent.

Soils of the Appling-Wedowee-Ashlar-Louisburg-Vance-Worsham series (VA030) moderate to very deep that formed in residuum from weathered igneous, metamorphic, and crystalline rock of the Piedmont Plateau. Soils range from excessively to poorly drained, with moderately rapid to slow permeability.

Soils of the Bourne-Colfax-Tetotum-Chewacla-Caroline series (VA034) are deep to very deep and somewhat poorly to moderately well to well drained. They formed in stratified marine and fluvial deposits, in materials

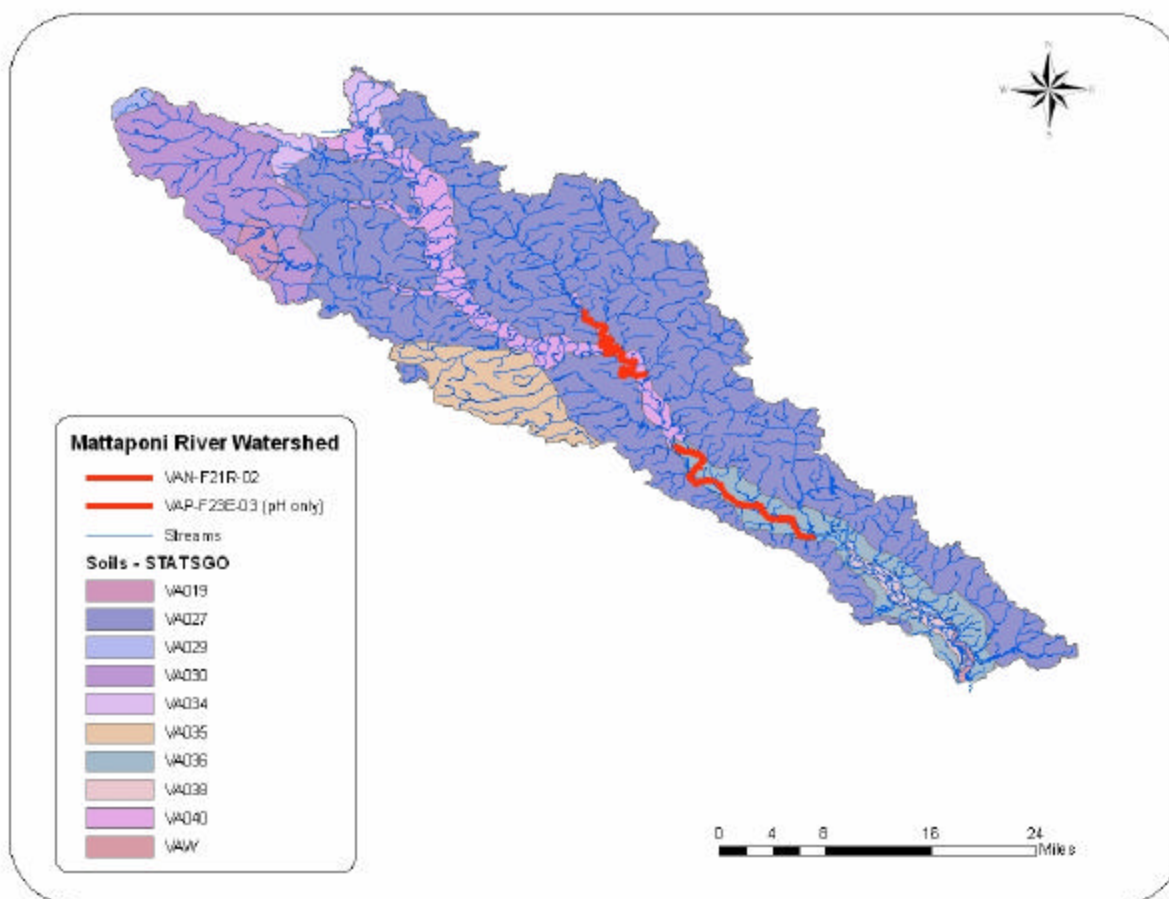
weathered from granitic rocks, or moderately fine textured fluvial or marine sediments underlain by stratified coarse to medium textured sediments, or on floodplains from recent alluvium washed largely from soils formed in residuum from schist, gneiss, granite, phyllite, and other metamorphic and igneous rocks. Permeability is moderately slow to slow, moderately permeable, or moderate in the upper part of the solum to slow to very slow in the fragipan. Slopes range from 0 to 25 percent.

The Craven-Mattaponi-Lenoir (VA035) series consists of well or moderately well drained to somewhat poorly drained soils. Permeability for these general soils is moderately slow to slow. This series is formed on cappings in the Piedmont and Coastal Plain uplands that formed in clayey sediments.

Soils of the Tetotum-Nansemond-State-Emporia-Draxton-Nimmo-Bladen Series (VA036) are very deep and range from well drained to poorly drained. Permeability ranges from moderately rapid and/or rapid to moderately slow or slow. This soil series was formed in sandy or loamy fluvial and marine sediments on Coastal Plain uplands and stream terraces.

The Pamunkey-Nansemond-Bibb-Kinston-Nawney-Bohicket Series (VA038) is very deep, poorly to well drained soils, and range from well to moderately well to slow permeability. These soils are located on low stream or marine terraces and in the flood plains in the Piedmont and the Coastal Plain Physiograph Provinces. These soil series are formed in fine to coarse loamy marine and fluvial sediments and sandy alluvium.

Soils of the Bojac-Pamunkey-Munden-Angie-Augusta-Molena-Argent (VA040) series are found mainly in floodplains and terraces. These soils are very deep and range from well drained to poorly or very poorly drained. Permeability for this series ranges from moderately rapid in the uplands to slowly permeable soils formed in clayey marine sediments.

**Figure 2. Soil Characteristics of the Mattaponi River Watershed.**

### ***Climate***

The climate summary for the Mattaponi River comes from a weather station located in Walkerton, VA, with a period of record from 7/ 1/1932 to 3/31/2004. The average annual maximum and minimum temperature (°F) at the weather station is 69.4 and 45.8 and the annual rainfall (inches) is 43.92 (Table 2) (Southeast Regional Climate Center, [http://www.sercc.com/climateinfo/historical/historical\\_va.html](http://www.sercc.com/climateinfo/historical/historical_va.html)).

**Table 2. Climate summary for Walkerton, Virginia (448829)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
<b>Average Max. Temperature (F)</b>	48.1	51.3	60.0	70.6	78.3	85.4	88.3	86.8	81.2	71.2	61.1	50.3	69.4
<b>Average Min. Temperature (F)</b>	26.4	27.7	34.7	43.8	53.7	62.4	66.7	65.4	58.3	45.9	36.5	28.5	45.8
<b>Average Total Precipitation</b>	3.47	3.08	3.86	3.07	3.92	3.75	4.91	4.52	3.78	3.07	3.24	3.26	43.92

(in.)													
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### Land Use

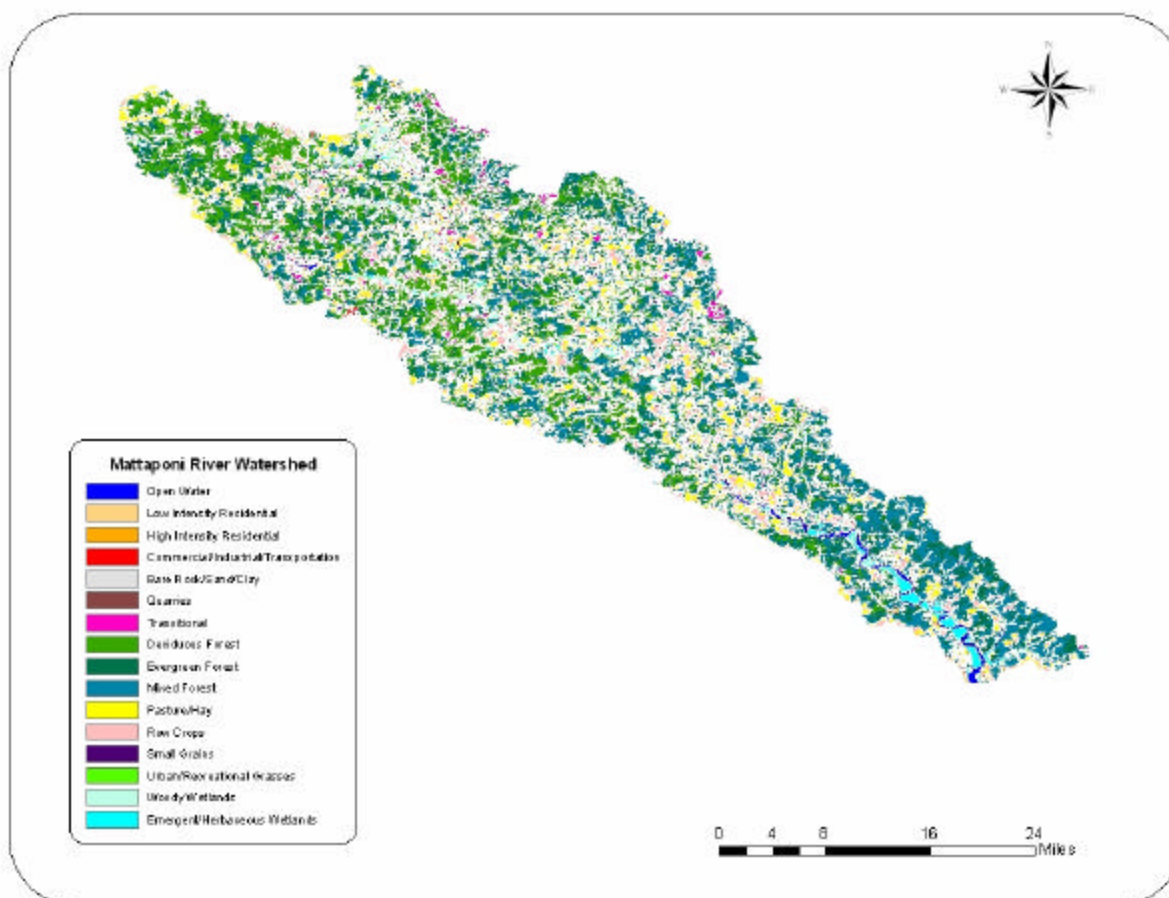
The Mattaponi River is approximately 104 miles long and flows southeast from the confluence of the Matta and Poni Rivers near Woodford, VA, to its confluence with the York River. The mainstem watershed is approximately 490,473 acres in size and is predominately forested (67.3 percent). Agriculture encompasses 20.2 percent of the watershed, with 11.5 percent cropland and 8.7 pasture/hayland. Low intensity residential and commercial/industrial areas compose approximately 1.0 percent of the land base. The remaining 11.6 percent of the watershed is comprised of 2.1 percent of transitional areas and grasses, and 7.4 percent wetlands and 2.1 percent open water. Land use is described in Table 3.

A map of the distribution of land use in the watershed (Figure 3) shows that forest land covers the majority of the watershed with the small portions of agricultural land interspersed throughout the watershed.

**Table 3. Land Use in the Mattaponi River Watershed**

Landuse	Count	Acres	SqMiles	Percentage
Open Water	45502	10119.4101006840	15.78628	2.06
Perennial Ice/Snow	0	0.0000000000	0.00000	0.00
Low Intensity Reside	13698	3046.3645457160	4.75233	0.62
High Intensity Resid	58	12.8989008360	0.02012	0.00
Commercial/Industria	8189	1821.1913611380	2.84106	0.37
Bare Rock/Sand/Clay	344	76.5038256480	0.11935	0.02
Quarries/Strip Mines	0	0.0000000000	0.00000	0.00
Transitional	47287	10516.3848936540	16.40556	2.14
Deciduous Forest	842337	187331.4040000000	292.23699	38.19
Evergreen Forest	176212	39188.6398985040	61.13428	7.99
Mixed Forest	465120	103440.2890000000	161.36685	21.09
Shrubland	0	0.0000000000	0.00000	0.00
Orchards/Vineyards/O	0	0.0000000000	0.00000	0.00
Grasslands/Herbaceou	0	0.0000000000	0.00000	0.00
Pasture/Hay	191334	42551.6946992280	66.38064	8.68
Row Crops	253032	56273.0116609440	87.78590	11.47
Small Grains	0	0.0000000000	0.00000	0.00
Fallow	0	0.0000000000	0.00000	0.00
Urban/Recreational G	0	0.0000000000	0.00000	0.00
Woody Wetlands	119743	26630.2255656060	41.54315	5.43
Emergent Herbaceous	42558	9464.6796858360	14.76490	1.93
Totals	2205414	490472.6980000000	765.13741	100.00

**Figure 3. Land Use in the mainstem Mattaponi River Watershed.**



### 3. Description of Water Quality Problem/Impairment

The Mattaponi River was listed as impaired on Virginia's 1998 Virginia Water Quality Assessment 305(b) Report (VADEQ 1998) and 2002 303(d) Report on Impaired Waters (VADEQ 2003) due to violations of the State's water quality standards for nutrients / eutrophication biological indicators (EPA overlist), chloride, pH estuarine bioassessments, and Fish Tissue – benzo(k)fluoranthene. This report evaluates the pH impairment by determining if natural conditions are the cause of the impairment, thus obviating the need for a TMDL. The nutrients / eutrophication biological indicators, chloride, estuarine bioassessments, and Fish Tissue – benzo(k)fluoranthene TMDLs will be performed on the Mattaponi River watershed in separate documents. Out of 346 pH values collected between March 1992 and September 2005 at station 8-MPN054.17, (Table 4), 51 were below the lower water quality standard for pH of pH 6 SU (Figure 4). Out of 419 pH values collected between February 1990 and August 2005 at station 8-MPN029.08, (Table 4), 75 were below the lower water quality standard for pH of pH 6 SU (Figure 5). Out of 93 pH values collected between August

1997 and September 2005 at station 8-MPN039.10, (Table 4), 13 were below the lower water quality standard for pH of pH 6 SU (Figure 6).

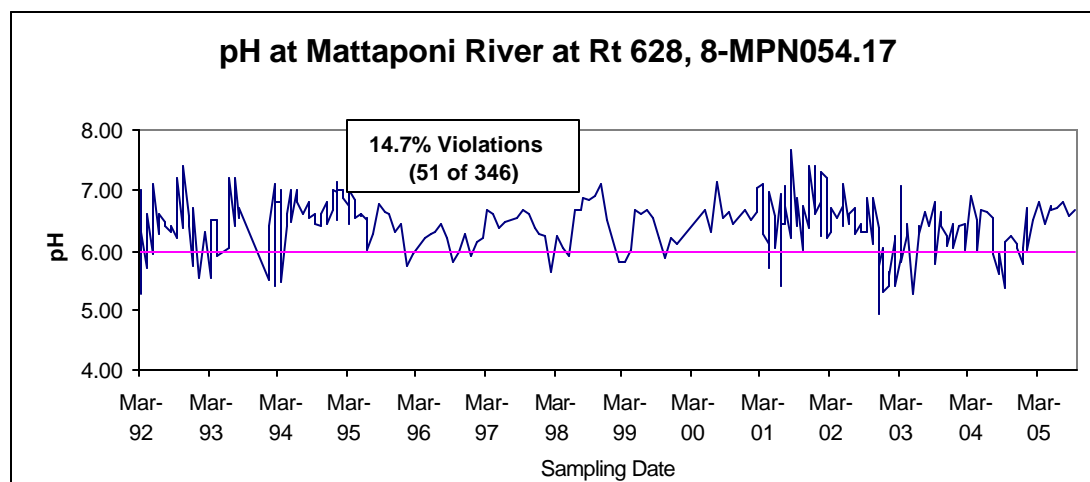
**Table 4. pH data collected by DEQ on the Mattaponi River at 8-MPN054.17, 8-MPN039.10, and 8-MPN029.08.**

Station	Date of First Sample	Date of Last Sample	Number of Samples	(SU)			Number of Exceedances*
				Average	Minimum	Maximum	
8-MPN054.17	03/09/1992	09/06/2005	346	6.45	4.91	7.66	51
8-MPN039.10	07/08/1997	09/29/2005	93	6.29	5.19	7.39	13
8-MPN029.08	02/14/1990	09/08/2005	419	6.40	5.22	8.14	75**

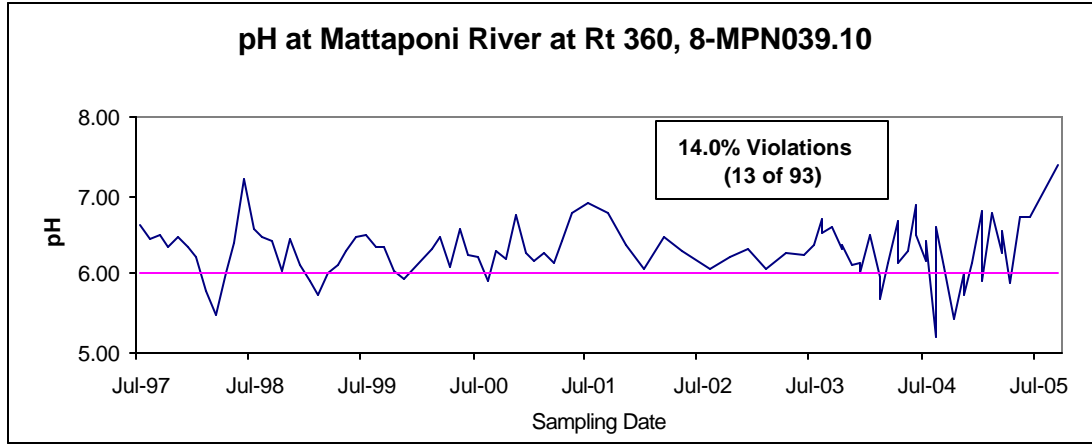
\* Exceedances of the minimum pH water quality standard of pH 6.0 SU. \*\* Two exceedances < pH 4 below 7Q10 flow removed because not wqs violations.

Time series graphs of data collected at stations 8-MPN054.17, 8-MPN039.10, and 8-MPN029.08 show the pH values, ranging from pH 4.91 at 8-MPN054.17 to pH 8.14 at 8-MPN029.08 SU (Figures 4 - 6). The horizontal line at the pH 6 SU marks represents the minimum water quality standard. The data points below the pH 6.0 SU line illustrate violations of the water quality standard.

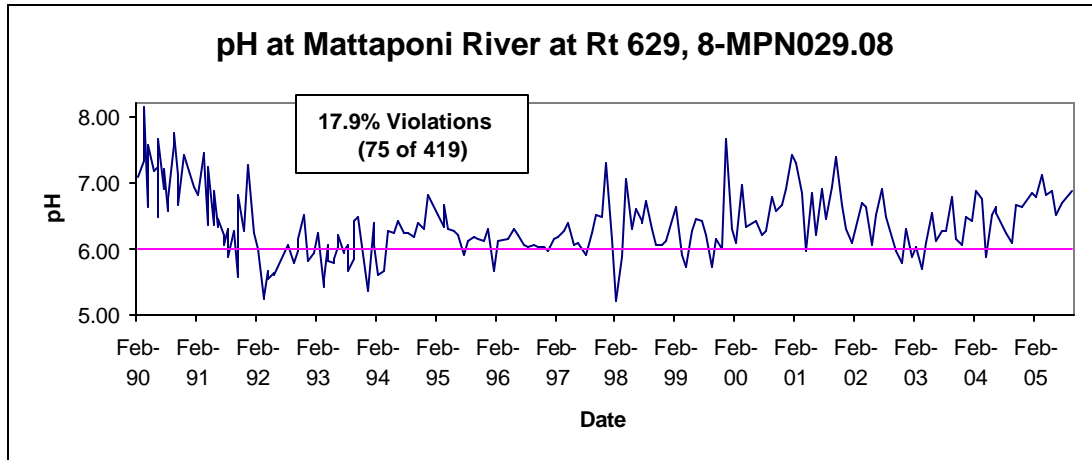
**Figure 4. Time series of pH concentrations (station 8-MPN054.17).**



**Figure 5. Time series of pH concentrations (station 8-MPN039.10).**



**Figure 6. Time series of pH concentrations (station 8-MPN029.08).**

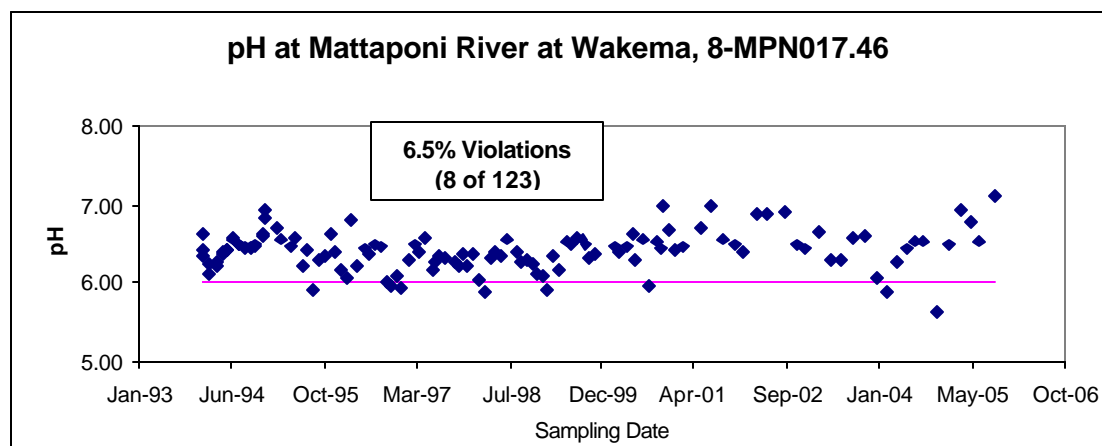


### **3.1 Associated Mainstem site pH**

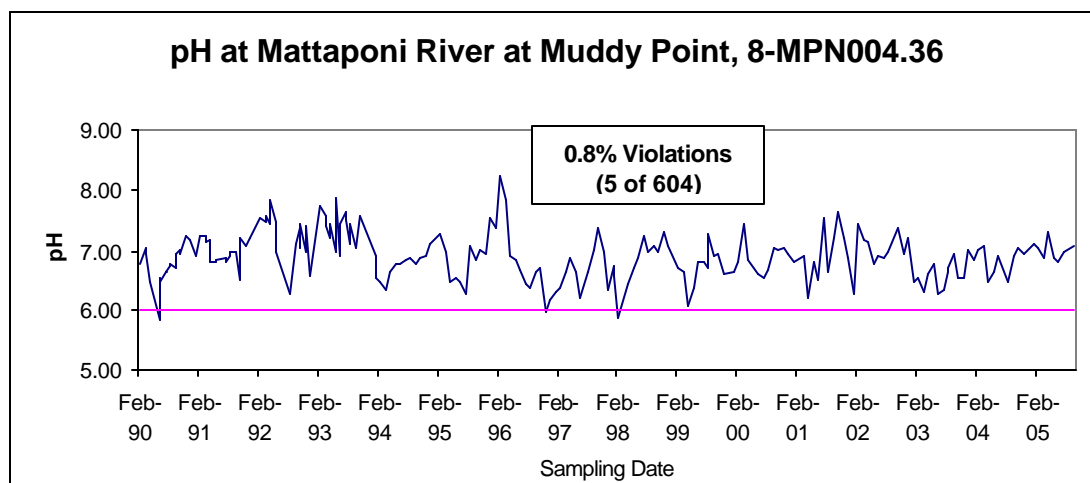
DEQ monitored two downstream mainstem stations during data collection for the low pH assessment of natural conditions or development of a TMDL. Associated station pH data are presented in Figures 7 and 8 below.

**Figure 7. pH at Mattaponi River at Wakema, 8-MPN017.46.**





**Figure 8. pH at Mattaponi River at Muddy Point, 8-MPN004.36**



## 4. Water Quality Standard

According to Virginia Water Quality Standards (9 VAC 25-260-5), the term “water quality standards means provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.).”

As stated above, Virginia water quality standards consist of a designated use or uses and a water quality criteria. These two parts of the applicable water quality standard are presented in the sections that follow.

#### 4.1. Designated Uses

According to Virginia Water Quality Standards (9 VAC 25-260-10A), “all state waters are designated for the following uses: recreational uses (e.g., swimming and boating); the propagation and growth of a balanced indigenous population of aquatic life, including game fish, which might be reasonably expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g., fish and shellfish).”

As stated above, the Mattaponi River must support all designated uses by meeting all applicable criteria. the Mattaponi River has been assessed as not supporting the aquatic life use due to the exceedance of the pH criteria that are designed to protect aquatic life in Class III waters.

#### 4.2. Applicable Water Quality Criteria

The Class III water quality criteria for pH in the Mattaponi River watershed is a minimum pH 6 SU and a maximum pH 9.0 SU (Table 5).

Table 5. Applicable water quality standards		
Parameter	Minimum pH SU	Maximum pH SU
pH	6.0	9.0

If the waterbody exceeds the criterion listed above in more than 10.5 percent of samples, the waterbody is classified as impaired and a TMDL must be developed and implemented to bring the waterbody into compliance with the water quality criterion. However, in the case of the Mattaponi River there is reason to believe that the waterbody has been mis-classified and that the apparent impairment is due to the swampy nature of the stream. In this document, VADEQ applies a proposed methodology for determining if DO and pH impairments in free-flowing streams are due to natural conditions. This methodology is based on a study done by MapTech in the Appomattox River Basin (MapTech 2003) and will be used here to determine if the pH impairments in the Mattaponi River are natural and if the Mattaponi River can be re-classified as Class VII (Swamp Waters).

#### 5. Methodology for Natural Conditions Assessment

The level of acidity as registered by pH in a water body is determined by a balance between organic acids produced by decay of vegetative material, and buffering capacity. Conditions in a stream that would typically be associated with naturally low pH include slow-moving, ripple-less waters or wetlands where the decay of organic matter produces organic acids. These situations can be compounded by anthropogenic activities that contribute excessive nutrients or readily available organic matter to these systems. The general

approach to determine if DO and pH impairments in streams are due to natural conditions is to assess a series of water quality and hydrologic criteria to determine the likelihood of an anthropogenic source. A logical 4-step process for identifying natural conditions that result in low DO and/or pH levels and for determining the likelihood of anthropogenic impacts that will exacerbate the natural condition is described below.

- Step 1. Determine slope and appearance.
- Step 2. Determine nutrient levels.
- Step 3. Determine degree of seasonal fluctuation (for DO only).
- Step 4. Determine anthropogenic impacts.

**The results from this methodology (or process or approach) will be used to determine if the stream should be re-classified as Class VII Swamp Waters. Each step is described in detail below.**

## Procedure for Natural Condition Assessment of low pH and low DO in Virginia Streams

Prepared by Virginia Department of Environmental Quality  
October 2004

### I. INTRODUCTION

Virginia's list of impaired waters currently shows many waters as not supporting the aquatic life use due to exceedances of pH and/or DO criteria that are designed to protect aquatic life in Class III waters. However, there is reason to believe that most of these streams or stream segments have been mis-classified and should more appropriately be classified as Class VII, Swamp Waters. This document presents a procedure for assessing if natural conditions are the cause of the low pH and/or low DO levels in a given stream or stream segment.

The level of dissolved oxygen (DO) in a water body is determined by a balance between oxygen-depleting processes (e.g., decomposition and respiration) and oxygen-restoring processes (e.g., aeration and photosynthesis). Certain natural conditions promote a situation where oxygen-restoring processes are not sufficient to overcome the oxygen-depleting processes. The level of acidity as registered by pH in a water body is determined by a balance between organic acids produced by decay of vegetative material, and buffering capacity.

Conditions in a stream that would typically be associated with naturally low DO and/or naturally low pH include slow-moving, ripple-less waters. In such waters, the decay of organic matter depletes DO at a faster rate than it can be replenished and produces organic acids (tannins, humic and fulvic substances). These situations can be compounded by anthropogenic activities that contribute excessive nutrients or readily available organic matter to these systems.

The general approach to determine if DO and pH impairments in streams are due to natural conditions is to assess a series of water quality and hydrologic criteria to determine the likelihood of an anthropogenic source. A logical 4-step process for identifying natural conditions that result in low DO and/or pH levels and for determining the likelihood of anthropogenic impacts that will exacerbate the natural condition is described below. DEQ staff is proposing to use this approach to implement State Water Control Law 9 VAC 25-260-55, Implementation Procedure for Dissolved Oxygen Criteria in Waters Naturally Low in Dissolved Oxygen.

Waters that are shown to have naturally low DO and pH levels will be re-classified as Class VII, Swamp Waters, with the associated pH criterion of 4.3 to 9.0 SU. An associated DO criterion is currently being developed from swamp water data. A TMDL is not needed for these waters. An assessment category of 4C will be assigned until the waterbody has been re-classified.

## **II. NATURAL CONDITION ASSESSMENT**

Following a description of the watershed (including geology, soils, climate, and land use), a description of the DO and/or pH water quality problem (including a data summary, time series and monthly data distributions), and a description of the water quality criteria that were the basis for the impairment determination, the available information should be evaluated in four steps.

### Step 1. Determine appearance and flow/slope.

Streams or stream segments that have naturally low DO (< 4 mg/L) and low pH (< 6 SU) are characterized by very low slopes and low velocity flows (flat water with low reaeration rates). Decaying vegetation in such swampy waters provides large inputs of plant material that consumes oxygen as it decays. The decaying vegetation in a swamp water also produces acids and decreases pH. Plant materials contain polyphenols such as tannin and lignin. Polyphenols and partially degraded polyphenols build up in the form of tannic acids, humic acids, and fulvic acids that are highly colored. The trees of swamps have higher polyphenolic content than the soft-stemmed vegetation of marshes. Swamp streams (blackwater) are therefore more highly colored and more acidic than marsh streams.

Appearance and flow velocity (or slope if flow velocity is not available) must be identified for each stream or stream segment to be assessed for natural conditions and potential re-classification as a Class VII swamp water. This can be done through maps, photos, field measurements or other appropriate means.

## Step 2. Determine nutrient levels.

Excessive nutrients can cause a decrease in DO in relatively slow moving systems, where aeration is low. High nutrient levels are an indication of anthropogenic inputs of nitrogen, phosphorus, and possibly organic matter. Nutrient input can stimulate plant growth, and the resulting die-off and decay of excessive plankton or macrophytes can decrease DO levels.

USGS (1999) estimated national background nutrient concentrations in streams and groundwater from undeveloped areas. Average nitrate background concentrations are less than 0.6 mg/L for streams, average total nitrogen (TN) background concentrations are less than 1.0 mg/L, and average background concentrations of total phosphorus (TP) are less than 0.1 mg/L.

Nutrient levels must be documented for each stream or stream segment to be assessed for natural conditions and potential re-classification as a Class VII swamp water. Streams with average concentrations of nutrients greater than the national background concentrations should be further evaluated for potential impacts from anthropogenic sources.

## Step 3. Determine degree of seasonal fluctuation (for DO only).

Anthropogenic impacts on DO will likely disrupt the typical seasonal fluctuation seen in the DO concentrations of wetland streams. Seasonal analyses should be conducted for each potential Class VII stream or stream segment to verify that DO is depressed in the summer months and recovers during the winter, as would be expected in natural systems. A weak seasonal pattern could indicate that human inputs from point or nonpoint sources are impacting the seasonal cycle.

## Step 4. Determine anthropogenic impacts.

Every effort should be made to identify human impacts that could exacerbate the naturally low DO and/or pH. For example, point sources should be identified and DMR data analyzed to determine if there is any impact on the stream DO or pH concentrations. Land use analysis can also be a valuable tool for identifying potential human impacts. Lastly, a discussion of acid rain impacts should be included for low pH waters. The format of this discussion can be based either on the process used for the recent Class VII classification of several streams in the Blackwater watershed of the Chowan Basin (letter from DEQ to EPA, 14 October 2003). An alternative is a prototype regional stream comparison developed for Fourmile Creek, White Oak Swamp, Matadequin Creek and Mechumps Creek (all east of the fall line). The example analysis under IV in this document, or the example report prepared for Fourmile Creek, illustrate this approach. For streams west of the fall line, a regional stream comparison for 2004 analyses encompasses Occupacia, Winticomack, and Skinquarter Creeks.

### 7Q10 Data Screen

If the data warrant it, a data screen should be performed to ensure that the impairment was identified based on valid data. All DO or pH data that violate water quality standards should be screened for flows less than the 7Q10. Data collected on days when flow was < 7Q10 should be eliminated from the data set and the violation rate recalculated accordingly. Only those waters with violation rates determined days with flows > or = 7Q10 flows should be classified as impaired.

In some cases, data were collected when flow was 0 cfs. If the 7Q10 is identified as 0 cfs as well, all data collected under 0 cfs flow would need to be considered in the water quality assessment. In those cases, the impairment should be classified as 4C, Impaired due to natural conditions, no TMDL needed. However, a reclassification to Class VII may not always be appropriate.

### **III. NATURAL CONDITION CONCLUSION MATRIX**

The following decision process should be applied for determining whether low pH and/or low DO values are due to natural conditions and justify a reclassification of a stream or stream segment as Class VII, Swamp Water.

- If velocity is low or if slope is low (<0.50%) AND
- If wetlands are present along stream reach AND
- If no point sources or only point sources with minimal impact on DO and pH AND
- If nutrients are < typical background
- ❖ average (= assessment period mean) nitrate less than 0.6 mg/L
- ❖ average total nitrogen (TN) less than 1.0 mg/L, and
- ❖ average total phosphorus (TP) are less than 0.1 mg/L AND
- For DO: If seasonal fluctuation is normal AND
- For pH: If nearby streams without wetlands meet pH criteria OR if no correlation between in-stream pH and rain pH,
- THEN determine as impaired due to natural condition
- assess as category 4C in next assessment
- initiate WQS reclassification to Class VII Swamp Water
- get credit under consent decree

The analysis must state the extent of the natural condition based on the criteria outlined above. A map showing land use, point sources, water quality stations and, if necessary, the delineated segment to be classified as swamp water should be included.

In cases where not all of these criteria apply, a case by case argument must be made based on the specific conditions in the watershed.

## **6. Natural Conditions Assessment for the Mattaponi River**

### **6.1 7Q10 Low Flow Screening**

The 7Q10 flow of a stream is the lowest streamflow for seven consecutive days that occurs on average once every ten years. The first step for low flow 7Q10 screening is to determine the most accurate 7Q10 available. There are two flow gaging stations on the Mattaponi River, Mattaponi River near Bowling Green, VA, 01674000, with a drainage area of 257 mi<sup>2</sup>, and Mattaponi River near Beulahville, VA, 01674500, with a drainage area of 601 mi<sup>2</sup>. The Beulahville gage is co-located with the VADEQ and USGS original listing station 8-MPN054.17. The 7Q10 flow for the Beulahville gage is 11 cfs.

The pH Instantaneous Water Quality Standard applies **AT** 7Q10 flow, but **NOT** below 7Q10 flow (9 VAC 25-260-50 \*\*\*). Therefore in streams where the 7Q10 > 0 cfs, pH less than 6 taken at flows below 7Q10 are not water quality standard violations. However, in streams where the 7Q10 = 0 cfs, **ALL** pH data < pH 6.0 mg/l are standard violations, even if the flow = 0 cfs when the pH was taken.

No Mattaponi River pH exceedances occurred below 7Q10 flow at upstream stations 8-MPN054.17 or 8-MPN039.10. However, at the lower station, 8-MPN029.08 at Walkerton, two low pH exceedances (pH 5.95 at 1m depth and pH 5.85 1m above bottom) occurred on October 8, 2002 at a flow of 9.6 cfs. These two low pH exceedances were removed from the dataset, dropping the violations to 17.9% (75 of 419).

### **6.2 Slope and Appearance**

The hydrologic slope from the 25 ft. topographic contour at rivermile 57.44, located 0.27 mi above the confluence with Maracossic Creek downstream to the 10 ft. topographic contour at rivermile 48.05 on the Mattaponi River 1.5 miles below the confluence with Gravel Run is estimated at 0.03% [(15 ft elev. / 9.39 mi \* 5280 ft length) X 100], which is considered very low slope. The low slope in this 9.39 mile segment contributes no human impact. The actual head of tide of the Mattaponi River between the confluence with Herring Creek and Old Hall Landing is difficult to pinpoint. However assuming that the head of tide was located at the confluence of Buckyard Branch at rivermile 42.22 between Herring Creek and Old Hall Landing, the overall slope from rivermile 57.44 downstream to rivermile 42.22 would also be estimated at 0.03% [(25 ft elev. / 15.22 mi X 5280 ft length) X 100].

The Mattaponi River from rivermile 57.44 downstream to rivermile 42.22 near head of tide exhibit extremely low slope (0.03%) and large areas of forested land, swamps and heavy tree canopy. Decomposition of the large inputs of decaying vegetation from areas of forested land with swamps and heavy tree canopy throughout the watershed lower pH as they decay. These are not considered anthropogenic impacts.

Visual inspections from bridges over the Mattaponi River and of its side channels at Rt 628 and Rt. 360 revealed large swampy areas. There are frequent side channels or oxbows connected to the mainstem. There are large inputs of decaying vegetation from such large swampy areas, oxbows, and from other areas of forested land with heavy tree canopy throughout the watershed, that produce acids and lower pH as they decay. (Figures 9 and 10).

**Figure 9. Mattaponi River at Rt. 628 side channel.**





**Figure 10. Mattaponi River swamp area beside channel near Rt. 360, Aylett, VA.**



### **6.3 Instream Nutrients**

The VADEQ collected nutrient data from stations 8-MPN054.17, 8-MPN039.10 and 8-MPN029.08 from February 1990 to October 2005. The average nutrient concentrations are below the USGS (1999) national background nutrient concentrations in streams from undeveloped areas levels of nitrate < 0.6 mg/l; TN (TDN + TPN) < 1.0 mg/l; and TP < 0.1 mg/l. These low nutrient levels are not indicative of human impact.

#### **8-MPN054.17**

<u>Parameter</u>	<u>Average Conc.</u>	<u>Number</u>
<b>Total Phosphorous</b>	<b>0.0638 mg/l</b>	(n=137)
Dissolved Orthophosphorous	0.0146 mg/l	(n=336)
Total Kjeldahl Nitrogen	0.514mg/l	(n=121)
Dissolved Ammonia as N	0.0297 mg/l	(n=326)
<b>Dissolved Nitrate as N</b>	<b>0.1566 mg/l</b>	(n=335)
Dissolved Nitrite as N	0.0019 mg/l	(n=336)
<b>TN (TDN + TPN)</b>	<b>0.6016 mg/l</b>	(n=144)
<b>TN (TKN + NO<sub>3</sub> + NO<sub>2</sub>)</b>	<b>NA, NO<sub>3</sub> + NO<sub>2</sub> dissolved only</b>	

**8-MPN039.10**

<u>Parameter</u>	<u>Average Conc.</u>	<u>Number</u>
<b>Total Phosphorous</b>	<b>0.0576 mg/l</b>	(n=71)
Orthophosphorous	0.0322 mg/l	(n=57)
Total Kjeldahl Nitrogen	0.5087mg/l	(n=57)
Ammonia as N	0.0313 mg/l	(n=57)
<b>Nitrate as N</b>	<b>0.2104 mg/l</b>	(n=57)
Nitrite as N	0.0087 mg/l	(n=57)
<b>TN (TKN + NO<sub>3</sub> + NO<sub>2</sub>)</b>	<b>0.7278 mg/l</b>	(n=57)

**8-MPN029.08**

<u>Parameter</u>	<u>Average Conc.</u>	<u>Number</u>
<b>Total Phosphorous</b>	<b>0.0761 mg/l</b>	(n=157)
Dissolved Orthophosphorous	0.0179 mg/l	(n=400)
Total Kjeldahl Nitrogen	0.5369mg/l	(n=157)
Dissolved Ammonia as N	0.0332 mg/l	(n=401)
<b>Dissolved Nitrate as N</b>	<b>0.1875 mg/l</b>	(n=401)
Dissolved Nitrite as N	0.0026 mg/l	(n=402)
<b>TN (TDN + TPN)</b>	<b>0.6412 mg/l</b>	(n=230)
<b>TN (TKN + NO<sub>3</sub> + NO<sub>2</sub>)</b>	<b>NA, NO<sub>3</sub> + NO<sub>2</sub> dissolved only</b>	

**6.4 Impact from Point Source Dischargers and Land Use**

There are 48 permitted facilities in the mainstem Mattaponi River watershed, as shown in Table 6. These are 10 VPDES, 6 Industrial Stormwater, 21 Construction Stormwater, 4 CAFO, 6 non-metallic mineral mining, and one ready-mix concrete facility.

**Table 6. VPDES, VAR, VPG, and VAG point source facilities in the Mattaponi River watershed**

Stream Name	Facility Name	VPDES Permit Number	Discharge Type <sup>1</sup>	Design Flow (MGD)	Permitted pH Limit
Polecat Creek	Caroline Co. Regional STP	VA0073504	Municipal Minor	0.5	6 to 9
UT to Polecat Creek	Pilot Travel Center 291	VA0085871	Industrial Minor	1.4	6 to 9
Stevens Mill Run	Lake Caroline WTP	VA0090930	Industrial Minor	0.29	6 to 9
UT to Maracossic Creek	Bowling Green Elementary and Bus Stop	VA0029726	Municipal Minor	0.0065	6 to 9
UT to Maracossic Creek	Hill Mobile Home Park	VA0082911	Municipal Minor	0.005	6 to 9
UT to Maracossic Creek	Hill Mobile Home Park STP 2	VA0090689	Municipal Minor	0.0048	6 to 9
UT to Herring Creek	DOC – Caroline Correctional Unit 2	VA0023329	Municipal Minor	0.37	6 to 9
UT to Mattaponi River	King and Queen Co. WTP	VA0088790	Municipal Minor	0.1	6 to 9
UT to Dickey's Swamp	Louisiana Land and Lumber LLC	VA0083119	Industrial Minor	NA	6 to 9
Mattaponi River	HRSD Town of West Point STP	VA0075434	Municipal Minor	0.6	6 to 9
UT to Stevens Mill Run	Pioneer Southern Ladysmith Plant	VAR051330	Industrial Stormwater	NL	NL
UT to Mattaponi River	Dejarnette Lumber Mill	VAR051126	Industrial Stormwater	NL	NL
UT to Mill Creek	Williamsburg Millwork Corporation	VAR051132	Industrial Stormwater	NL	NL
UT to Walkerton Br	Bennett Mineral Company Incorporated	VAR050632	Industrial Stormwater	NL	6 to 9

Glebe Swamp	Bohannon Lumber Company Inc.	VAR051194	Industrial Stormwater	NL	NL
Goulder's Creek	Middle Peninsula Regional Airport	VAR051609	Industrial Stormwater	NL	6 to 9
UT to Polecat Creek to Lake Caroline	Pendleton	VAR104651	Construction Stormwater	NL	NL
UT to Polecat Creek	VDOT Bowling Green 0095016111P101	VAR101769	Construction Stormwater	NL	NL
UT to Gravel Run	VDOT Saluda Residency 0665049P45N501	VAR101395	Construction Stormwater	NL	NL
Herring Creek	Woodruff III Subdivision Road Extension	VAR102155	Construction Stormwater	NL	NL
Mattaponi River	VDOT Saluda 00330966103C501	VAR103564	Construction Stormwater	NL	NL
Maracossic Creek	Bowling Green Meadows	VAR101684	Construction Stormwater	NL	NL
Dickeys Swamp	Private Residence	VAR104270	Construction Stormwater	NL	NL
UT to Mattaponi River	Private Residence	VAR103966	Construction Stormwater	NL	NL
UT to Aylett Creek	Parkwood Estates	VAR101978	Construction Stormwater	NL	NL
UT to Aylett Creek	Parkwood Estates	VAR101486	Construction Stormwater	NL	NL
Aylett Creek	Store More Incorporated	VAR102419	Construction Stormwater	NL	NL
UT to Walkerton Branch	VDOT Saluda 0634049130C501	VAR101687	Construction Stormwater	NL	NL
Garnetts Creek	King and Queen Fish Culture Station	VAR103558	Construction Stormwater	NL	NL
Mattaponi River	River Pines LLC	VAR102872	Construction Stormwater	NL	NL
Mattaponi River	Private Residence	VAR103570	Construction Stormwater	NL	NL
Mattaponi River	Private Residence	VAR103864	Construction Stormwater	NL	NL

Mattaponi River	Private Residence	VAR104100	Construction Stormwater	NL	NL
Custis Mill Creek	Mann Hill Farm	VAR102402	Construction Stormwater	NL	NL
Glebe Swamp	Independent Group – Bohannon Industrial Park	VAR103856	Construction Stormwater	NL	NL
Goose Creek	Private Residence	VAR102161	Construction Stormwater	NL	NL
Glass Island Creek	West Point Station	VAR103065	Construction Stormwater	NL	NL
Root Swamp	Sea Bee Acres	VPG140017	CAFO	NA	NL
Root Swamp	Sea Bee Acres	VPG100035	CAFO	NA	NL
Dickey's Swamp	Berry Edward T III	VPG140048	CAFO	NA	NL
Dickey's Swamp	Berry Edward T III	VPG100064	CAFO	NA	NL
UT to Mattaponi River	Luck Stone Corporation – Mattaponi Plant	VAG844069	NMMM	NL	6 to 9
UT to Mattaponi River	Luck Stone Corporation – Mattaponi Plant	VAG840151	NMMM	NL	6 to 9
UT to Mattaponi River	Luck Stone Corporation – New Market	VAG846046	NMMM	NL	6 to 9
UT to Mattaponi River	Luck Stone Corporation – New Market	VAG840146	NMMM	NL	6 to 9
UT to Mattaponi River	American Metals and Construction - Gloucester	VAG840160	NMMM	NL	6 to 9
UT to Mattaponi River	Essex Concrete – Aylett Sand and Gravel	VAG840161	NMMM	NL	6 to 9
UT to Mattaponi River	Beasley Concrete Incorporated – Milford Plant	VAG110206	Ready-Mix Concrete	NL	6 to 9

The facilities with largest design flows located upstream of the impaired segments, Caroline Co. Regional STP and Pilot Travel Center 291, are approximately 40 and 45 miles, respectively, upstream of the furthest

upstream impaired station at 8-MPN054.17 near Beulahville, VA. The Lake Caroline WTP is also approximately 45 miles upstream of the impaired segment. Bowling Green Elementary and Bus Stop, and Hill Mobile Home Park are located more than 20 miles upstream of the impaired segments, and are small quantity dischargers. The DOC – Caroline Correctional Unit 2 is located on a headwaters UT to Herring Creek approximately 17 miles upstream of the Herring Creek confluence with the Mattaponi River. The Louisiana Land and Lumber LLC is located far upstream on a UT to Dickey's Swamp, which flows into Dickey's Swamp and becomes Garnett's Creek, the tributary at the downstream end of the impaired segment. The HRSD Town of West Point STP and King and Queen County WTP are located well downstream of the impaired segments. All the VPDES dischargers are between 17 and 45 miles upstream of the impaired segments, or downstream of them, and probably exert no impact on the mainstem Mattaponi River at these distances.

In the industrial stormwater category, Pioneer Southern Ladysmith Plant is located more than 45 miles upstream of the impaired segment. Dejarnette Lumber Mill and Williamsburg Millwork Corporation are approximately 25 miles upstream of the impaired segment. Stormwater from Bennett Mineral Company Incorporated drains to a UT of Walkerton Branch, and then into large Walkerton Millpond before reaching the tidal Mattaponi River. Bohannon Lumber Company, Inc. and the Middle Peninsula Regional Airport are far downstream near West point, VA. Three of the industrial stormwater dischargers are between 25 and 45 miles upstream, and two are downstream of the impaired segments, and probably exert no impact on the mainstem Mattaponi River at these distances. One facility drains to a UT, then into a perennial stream for 3 miles before diluting in a large millpond, also probably exerting no impact on the mainstem Mattaponi River at that distance and dilution.

There are no pH limits in the 21 construction stormwater permits, which are short term runoff events during a period of construction. CAFO facilities are not allowed to discharge waste. These probably have no effect on low pH in the mainstem Mattaponi River. The Residential / Commercial land use (0.99%) probably has no pH effect on streams in the watershed. The watershed is predominately forested (67.3 percent).

## **6.5 Human Impact from Acid Deposition**

Acid deposition is expected to occur in the Mattaponi River watershed, however rainfall pH data are difficult to collect and do not exist near the Mattaponi River. The closest available rainfall pH data come from the National Atmospheric Deposition Program /NTN station in Charlottesville, VA. Acid deposition occurred in the Charlottesville dataset, with weekly rainfall pH during the period from 1990 to 2003 averaging 4.35 SU (SD = 0.277, n = 428), with a minimum of 3.43 SU and maximum of 5.29 SU. According to an EPA web site (<http://www.epa.gov/airmarkets/acidrain/index.html>) the natural pH of rain is about 5.5.

One method to assess whether acid deposition adversely impacts low pH in a waterbody is to compare daily precipitation data from the Virginia State Climatology Office to DEQ ambient water quality monitoring field pH data. During the last DEQ water quality standards triennial review in 2003, DEQ filtered daily rainfall data for 1996 - 2003 according to water sample collection dates at DEQ ambient water quality monitoring stations that were within an approximate 15-mile radius of precipitation monitoring stations. Precipitation amounts and field pH values were graphed together and correlation factors calculated. The only discernable pattern was a general negative correlation of precipitation to pH and the majority of r-values were well below 0.5, which does not indicate a close correlation between the variables. This comparison is described in correspondence to USEPA Region III dated October 14, 2003 in Appendix B. However the extent to which stream pH is decreased by acid deposition in Virginia cannot be decisively established. Significant human impact from acid deposition is inconclusive.

## **7.0 CONCLUSION**

***The following decision process is proposed for determining whether low pH values are due to natural conditions:***

If slope is low (<0.50) AND

If wetlands are present along stream reach AND

If no point sources or point sources with minimal impact on pH AND

If nutrients are < typical background

❖ average (= assessment period mean) nitrate less than 0.6 mg/L

❖ average total nitrogen (TN) less than 1.0 mg/L, and

❖ average total phosphorus (TP) are less than 0.1 mg/L AND

If nearby streams without wetlands meet pH criteria,

THEN determine as impaired due to natural condition

→ assess as category 4C in next assessment

→ initiate WQS reclassification to Class VII Swamp Water

→ get credit under consent decree

The Mattaponi River exhibits low slope with significant swamplands, oxbows, and large areas of forested land. There are large inputs of decaying vegetation from such large swampy areas, oxbows, and from other areas of forested land with heavy tree canopy throughout the watershed, that produce acids and lower pH as they decay. These are not considered anthropogenic impacts.

The Mattaponi River exhibits low nutrient concentrations below national background levels in streams from undeveloped areas, which not indicative of human impact.

VPDES dischargers are all between 17 and 45 miles upstream of the impaired segments, or downstream of them, and probably exert no impact on the mainstem Mattaponi River at these distances. Three industrial stormwater dischargers are between 25 and 45 miles upstream, and two are downstream of the impaired segments, and probably exert no impact on the mainstem Mattaponi River. One facility drains to a UT, then into a perennial stream for 3 miles before diluting in a large millpond, also probably exerting no impact on the mainstem Mattaponi River at that distance and dilution. Short term construction stormwater permits, and CAFOs which cannot discharge legally also probably have no effect on low pH in the mainstem Mattaponi River. The Residential / Commercial land use (0.99%) probably has no pH effect on streams in the watershed. The watershed is predominately forested (67.3 percent).

There is not a close correlation between precipitation amounts and field pH at DEQ ambient water quality monitoring stations. The only discernable pattern has been a general negative correlation of precipitation to pH and the majority of r-values were well below 0.5, which does not indicate a close correlation between the variables. However the extent to which stream pH is decreased by acid deposition cannot be conclusively determined.

Based on the above information, a change in the water quality standards classification to Class VII Swampwater due to natural conditions, rather than a TMDL, is indicated for the Mattaponi River from its confluence with Maracossic Creek at river mile 57.17 downstream to the tidal confluence with Garnetts Creek at river mile 23.60. Garnetts Creek is half way between station 8-MPN029.08 at Walkerton and station 8-MPN017.46 at Wakema, where low pH occurs less than 10 percent of samples. The total miles classified as Swampwaters are 33.57 river miles and 1.96 estuarine square miles.

## ***8.0. Public Participation***

DEQ performed the assessment of the Mattaponi River low pH natural condition in lieu of a TMDL. Therefore neither a TMDL Technical Advisory Committee (TAC) meeting nor a public meeting was involved. Public participation will occur during the next water quality standards triennial review process.

## 9.0 References

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## **Appendix A**

### **Glossary**

## GLOSSARY

**Note:** All entries in italics are taken from USEPA (1998). All non-italicized entries are taken from MapTech (2002).

**303(d).** A section of the Clean Water Act of 1972 requiring states to identify and list water bodies that do not meet the states' water quality standards.

***Ambient water quality.*** Natural concentration of water quality constituents prior to mixing of either point or nonpoint source load of contaminants. Reference ambient concentration is used to indicate the concentration of a chemical that will not cause adverse impact on human health.

***Anthropogenic.*** Pertains to the [environmental] influence of human activities.

***Background levels.*** Levels representing the chemical, physical, and Bacterial conditions that would result from natural geomorphological processes such as weathering or dissolution.

***Best management practices (BMPs).*** Methods, measures, or practices determined to be reasonable and cost-effective means for a landowner to meet certain, generally nonpoint source, pollution control needs. BMPs include structural and nonstructural controls and operation and maintenance procedures.

***Clean Water Act (CWA).*** The Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972), Public Law 92-500, as amended by Public Law 96-483 and Public Law 97-117, 33 U.S.C. 1251 et seq. The Clean Water Act (CWA) contains a number of provisions to restore and maintain the quality of the nation's water resources. One of these provisions is section 303(d), which establishes the TMDL program.

***Concentration.*** Amount of a substance or material in a given unit volume of solution; usually measured in milligrams per liter (mg/L) or parts per million (ppm).

***Confluence.*** The point at which a river and its tributary flow together.

***Contamination.*** The act of polluting or making impure; any indication of chemical, sediment, or Bacterial impurities.

***Designated uses.*** Those uses specified in water quality standards for each waterbody or segment whether or not they are being attained.

**Dilution.** *The addition of some quantity of less-concentrated liquid (water) that results in a decrease in the original concentration.*

**Direct runoff.** *Water that flows over the ground surface or through the ground directly into streams, rivers, and lakes.*

**Discharge.** *Flow of surface water in a stream or canal, or the outflow of groundwater from a flowing artesian well, ditch, or spring. Can also apply to discharge of liquid effluent from a facility or to chemical emissions into the air through designated venting mechanisms.*

**Discharge permits (under VPDES).** *A permit issued by the U.S. EPA or a state regulatory agency that sets specific limits on the type and amount of pollutants that a municipality or industry can discharge to a receiving water; it also includes a compliance schedule for achieving those limits. The permit process was established under the National Pollutant Discharge Elimination System, under provisions of the Federal Clean Water Act.*

**Domestic wastewater.** *Also called sanitary wastewater, consists of wastewater discharged from residences and from commercial, institutional, and similar facilities.*

**Drainage basin.** *A part of a land area enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into a receiving water. Also referred to as a watershed, river basin, or hydrologic unit.*

**Effluent.** *Municipal sewage or industrial liquid waste (untreated, partially treated, or completely treated) that flows out of a treatment plant, septic system, pipe, etc.*

**Effluent limitation.** *Restrictions established by a state or EPA on quantities, rates, and concentrations in pollutant discharges.*

**Existing use.** *Use actually attained in the waterbody on or after November 28, 1975, whether or not it is included in the water quality standards (40 CFR 131.3).*

**GIS.** *Geographic Information System. A system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth. (Dueker and Kjerne, 1989)*

**Hydrologic cycle.** *The circuit of water movement from the atmosphere to the earth and its return to the atmosphere through various stages or processes, such as precipitation, interception, runoff, infiltration, storage, evaporation, and transpiration.*

**Hydrology.** *The study of the distribution, properties, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.*

***In situ.*** *In place; in situ measurements consist of measurements of components or processes in a full-scale system or a field, rather than in a laboratory.*

***Margin of safety (MOS).*** *A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving waterbody (CWA section 303(d)(1)(C)). The MOS is normally incorporated into the conservative assumptions used to develop TMDLs (generally within the calculations or models) and approved by EPA either individually or in state/EPA agreements. If the MOS needs to be larger than that which is allowed through the conservative assumptions, additional MOS can be added as a separate component of the TMDL (in this case, quantitatively, a  $TMDL = LC = WLA + LA + MOS$ ).*

***Mean.*** *The sum of the values in a data set divided by the number of values in the data set.*

***MGD.*** *Million gallons per day. A unit of water flow, whether discharge or withdraw.*

***Monitoring.*** *Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.*

***Narrative criteria.*** *Nonquantitative guidelines that describe the desired water quality goals.*

***National Pollutant Discharge Elimination System (NPDES).*** *The national program for issuing, modifying, revoking and re-issuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act.*

***Natural waters.*** *Flowing water within a physical system that has developed without human intervention, in which natural processes continue to take place.*

***Non-point source.*** *Pollution that originates from multiple sources over a relatively large area. Nonpoint sources can be divided into source activities related to either land or water use including failing septic tanks, improper animal-keeping practices, forest practices, and urban and rural runoff.*

***Numeric targets.*** *A measurable value determined for the pollutant of concern, which, if achieved, is expected to result in the attainment of water quality standards in the listed waterbody.*

***Organic matter.*** *The organic fraction that includes plant and animal residue at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized*

*by the soil population. Commonly determined as the amount of organic material contained in a soil or water sample.*

**Peak runoff.** *The highest value of the stage or discharge attained by a flood or storm event; also referred to as flood peak or peak discharge.*

**Permit.** *An authorization, license, or equivalent control document issued by EPA or an approved federal, state, or local agency to implement the requirements of an environmental regulation; e.g., a permit to operate a wastewater treatment plant or to operate a facility that may generate harmful emissions.*

**Point source.** *Pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving water stream or river.*

**Pollutant.** *Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, Bacterial materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water. (CWA section 502(6)).*

**Pollution.** *Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, Bacterial, chemical, and radiological integrity of water.*

**Public comment period.** *The time allowed for the public to express its views and concerns regarding action by EPA or states (e.g., a Federal Register notice of a proposed rule-making, a public notice of a draft permit, or a Notice of Intent to Deny).*

**Raw sewage.** *Untreated municipal sewage.*

**Receiving waters.** *Creeks, streams, rivers, lakes, estuaries, ground-water formations, or other bodies of water into which surface water and/or treated or untreated waste are discharged, either naturally or in man-made systems.*

**Restoration.** *Return of an ecosystem to a close approximation of its presumed condition prior to disturbance.*

**Riparian areas.** *Areas bordering streams, lakes, rivers, and other watercourses. These areas have high water tables and support plants that require saturated soils during all or part of the year. Riparian areas include both wetland and upland zones.*

**Riparian zone.** *The border or banks of a stream. Although this term is sometimes used interchangeably with floodplain, the riparian zone is generally regarded as relatively narrow compared to a floodplain. The duration of flooding is generally much shorter, and the timing less predictable, in a riparian zone than in a river floodplain.*

**Runoff.** *That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into receiving waters.*

**Slope.** *The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25 or 1 on 25, indicating one unit vertical rise in 25 units of horizontal distance, or in a decimal fraction (0.04), degrees (2 degrees 18 minutes), or percent (4 percent).*

**Stakeholder.** *Any person with a vested interest in assessment of natural condition or TMDL development.*

**Standard.** *In reference to water quality (e.g. pH 6 – 9 SU limit).*

**Storm runoff.** *Storm water runoff, snowmelt runoff, and surface runoff and drainage; rainfall that does not evaporate or infiltrate the ground because of impervious land surfaces or a soil infiltration rate lower than rainfall intensity, but instead flows onto adjacent land or into waterbodies or is routed into a drain or sewer system.*

**Streamflow.** *Discharge that occurs in a natural channel. Although the term "discharge" can be applied to the flow of a canal, the word "streamflow" uniquely describes the discharge in a surface stream course. The term "streamflow" is more general than "runoff" since streamflow may be applied to discharge whether or not it is affected by diversion or regulation.*

**Stream restoration.** *Various techniques used to replicate the hydrological, morphological, and ecological features that have been lost in a stream because of urbanization, farming, or other disturbance.*

**Surface area.** *The area of the surface of a waterbody; best measured by planimetry or the use of a geographic information system.*

**Surface runoff.** *Precipitation, snowmelt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants.*

**Surface water.** *All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors directly influenced by surface water.*

**Topography.** *The physical features of a geographic surface area including relative elevations and the positions of natural and man-made features.*

**Total Maximum Daily Load (TMDL).** *The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources and natural background, plus a margin of safety (MOS). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard.*

**Tributary.** *A lower order-stream compared to a receiving waterbody. "Tributary to" indicates the largest stream into which the reported stream or tributary flows.*

**Variance.** *A measure of the variability of a data set. The sum of the squared deviations (observation – mean) divided by (number of observations) – 1.*

**DCR.** Department of Conservation and Recreation.

**DEQ.** Virginia Department of Environmental Quality.

**VDH.** Virginia Department of Health.

**Wastewater.** *Usually refers to effluent from a sewage treatment plant. See also Domestic wastewater.*

**Wastewater treatment.** *Chemical, Bacterial, and mechanical procedures applied to an industrial or municipal discharge or to any other sources of contaminated water to remove, reduce, or neutralize contaminants.*

**Water quality.** *The Bacterial, chemical, and physical conditions of a waterbody. It is a measure of a waterbody's ability to support beneficial uses.*

**Water quality criteria.** *Elements of the board's water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated use.*

**Water quality standard.** *Provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§ 62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC § 1251 et seq.).*

***Watershed.*** *A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.*

## **Appendix B**

**CLASS VII RE-CLASSIFICATION LETTER TO USEPA USED IN LAST TRIENNIAL REVIEW**

**Dated October 14, 2003**



**ATTACHMENT III – CLASS VII RE-CLASSIFICATION LETTER USED IN LAST TRIENNIAL REVIEW**

October 14, 2003

MEMORANDUM

TO: EPA Region 3  
FROM: David C. Whitehurst  
SUBJECT: Supporting Data for Proposed Class VII (Swamp Waters) pH Criteria

As required by 40 CFR § 131.20, the purpose of this memo is to provide supporting data and information for Virginia's proposed classification change for several water bodies within the state. The Virginia Department of Environmental Quality (DEQ) has adopted a revised numerical pH criterion for some waters of the southeastern portion of the state as an effort to reflect the natural conditions of those waters and as an aid for the appropriate assessment of these waters. This criterion change is allowed according to 40 CFR § 131.11. (b). (1). (iii).

These waters were classified by the Virginia Water Quality Standards as Class III Coastal and Piedmont Nontidal Waters (9 VAC 25-260-50), with a pH range of 6.0 to 9.0 as is the case for all classes of waters statewide. The amendments to 9 VAC 25-260-5 define Class VII waters as "...waters with naturally occurring low pH and low dissolved oxygen caused by:

(1) low flow velocity that prevents mixing and re-aeration of stagnant, shallow waters and (2) decomposition of vegetation that lowers dissolved oxygen concentrations and causes tannic acids to color the water and lower the pH." The proposed pH criterion for Class VII waters is 4.3 to 9.0. The proposed amendments are a change in the numerical criterion for a particular type or class of water body and not an alteration of designated uses. Aquatic life uses shall be maintained and required effluent pH limits of 6.0 - 9.0 shall be maintained for all discharges to Class VII waters.

The water bodies that are proposed for Class VII designation are frequently referred to as blackwater streams/rivers due to the characteristic dark color that is a result of staining by fulvic and humic acids. The water chemistry is generally characterized by low buffering capacity and high acidity. The pH in peat draining blackwater systems can range from 3.5 - 6 and in mineral soil draining systems from 4 - 7. The naturally occurring acidic conditions of Mid-Atlantic Coastal Plain blackwater streams is well documented in peer reviewed scientific literature (Appendices A, B and G). The US Environmental Protection Agency 1997 publication "Field and laboratory methods for macroinvertebrate and habitat assessment of low gradient nontidal streams" states that "Coastal plain streams are

often naturally acidic due to the high concentration of humic and fulvic acids found in the water draining swamp soils. The pH of these streams most often ranges from 3.5 to 7.5." (Appendix B)

Ambient water quality monitoring field pH data for stations within waters that are proposed as Class VII is presented in Appendix C as is a photo representative of the water body. Where sufficient data was available, pH values were averaged for each monitoring station on a water body and graphed. Individual pH values for each monitoring station were also graphed. The majority (> 50%) of individual pH values were below 7.

In an effort to confirm that point source discharges were not contributing to the low pH values, the DEQ permitting database was queried for pH violations ( $\text{pH} < 6$ ) at permitted outfalls located on the proposed water bodies (Appendix D). One facility had two compliance violations (failure to report pH), one facility had three violations for discharge over the upper limit for pH ( $\text{pH} > 9$ ), and one facility for effluent discharge less than the lower require limit ( $\text{pH} < 6$ ). All of the discharges are less than 1.0 MGD and the discharges are to small tributaries to the proposed Class VII waterbodies.

At the request of EPA Region 3 for DEQ to demonstrate that proposed Class VII waters are not impacted by acid rain that would unnaturally lower pH, daily precipitation data from the Virginia State Climatology Office was compared to DEQ ambient water quality monitoring field pH data (Appendix E). Daily rainfall data for 1996 - 2003 was filtered according to water sample collection dates at DEQ ambient water quality monitoring stations that are within an approximate 15-mile radius of precipitation monitoring stations. Precipitation amounts and field pH values were graphed together and correlation factors calculated. The only discernable pattern was a general negative correlation of precipitation to pH and the majority of r-values were well below 0.5, which does not indicate a close correlation between the variables.

According to an EPA web site (<http://www.epa.gov/airmarkets/acidrain/index.html>) the natural pH of rain is about 5.5 and the average pH of rainfall for the southeast/south-central region of Virginia, where the proposed Class VII waters are located, is 4.6 (Appendix F). Due to the naturally acidic conditions and low acid neutralizing capacity of the Virginia Coastal Plains watersheds, they are considered to be sensitive to atmospheric acid deposition (acid rain) and the effects may either be ameliorated or exacerbated by the type of land use in the watershed. A joint pilot study of episodic acidification of first order blackwater streams in southeastern Virginia conducted by Virginia Commonwealth University and DEQ found significant differences between pH depression duration and magnitude. Study sites within undisturbed old growth watersheds showed the greatest pH depressions and study sites within deforested and agricultural watersheds exhibited less severe pH depressions (Appendix G).

Other states such as North Carolina have narrative and numerical criteria in their water quality standards that recognize some waters may have characteristics outside of the "normal" range established by statewide standards (Appendix H). In light of this and other information presented here, it is logical and necessary that Virginia alter its numerical criterion for pH to reflect the naturally occurring conditions within certain water bodies in the state.

#### Attachments